



Learning Management System–Supported Project-Based Learning and Its Effect on Students’ Critical Thinking Disposition

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Abstract

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Learning Management Systems (LMS) play a central role in supporting technology-mediated instructional design in higher education, enabling flexible learning environments that integrate student-centered pedagogical approaches. Project-Based Learning (PjBL), when supported by LMS platforms, has the potential to enhance higher-order thinking; however, empirical evidence regarding its effectiveness in developing students’ critical thinking disposition remains limited. This study aims to examine the effect of LMS-supported Project-Based Learning on students’ critical thinking disposition within a flexible learning environment. A quasi-experimental method with a one-group pretest–posttest design was employed involving 93 undergraduate students enrolled in three core courses in the Electronic Engineering Education Study Program at Universitas Negeri Jakarta during the 2024/2025 academic year. Critical thinking disposition was measured using a validated instrument covering seven dispositional dimensions. Data were analyzed using paired sample t-test and N-Gain index. The results indicate a statistically significant improvement in overall critical thinking disposition scores ($t = 4.57$; $p < 0.05$); however, the N-Gain value (0.09) suggests low practical effectiveness. Improvements were more prominent in procedural dimensions such as analyticity and systematicity, while epistemic dimensions showed limited development. These findings highlight that LMS-supported Project-Based Learning contributes to procedural aspects of critical thinking disposition but requires complementary instructional design strategies emphasizing reflective dialogue, argumentation, and epistemic engagement to achieve deeper dispositional development. This study contributes to educational technology research by demonstrating the importance of aligning technological tools with pedagogical design to maximize the effectiveness of LMS-supported learning environments.

Keywords:

Project-Based Learning; Learning-Management System; Distance Learning; Critical-Thinking Disposition

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INTRODUCTION

The integration of 21st-century competencies into higher education has become an essential foundation for preparing students to face complex academic and professional challenges. Critical thinking is widely recognized as a fundamental skill for problem-solving, decision-making, and analytical reasoning (Facione, 2000a)(Zulmaulida & Dahlan, 2018). Beyond cognitive skills, critical thinking also involves dispositional aspects that reflect individuals’ tendencies to consistently engage in reflective, analytical, and open-minded thinking processes (Ennis, 1996)(Ennis, 2011)(Facione et al., 1997). Developing critical thinking disposition is therefore considered essential for preparing students to navigate complex learning environments and professional challenges.



Within the field of educational technology, Learning Management Systems (LMS) have emerged as key instructional infrastructures that support flexible learning design, digital interaction, and technology-mediated pedagogy (Churiyah et al., 2020) (Herliandry & Suban, 2020). In line with institutional policies at Universitas Negeri Jakarta that allow flexible learning modalities—including online, offline, and blended formats—LMS platforms provide opportunities to implement student-centered instructional strategies supported by structured digital environments. LMS integration enables asynchronous communication, collaborative learning, and systematic monitoring of learning processes, which may contribute to the development of higher-order thinking skills (Anhusadar, 2020) (Dubey & Pandey, 2020) (T. N. Fitria, 2020).

Project-Based Learning (PjBL) represents a pedagogical approach aligned with constructivist learning principles, emphasizing authentic tasks, inquiry-based learning, and collaborative problem-solving (D. Fitria et al., 2019) (Diarini et al., 2020). Previous studies have demonstrated that PjBL can improve learning outcomes, motivation, creativity, and critical thinking skills (Diarini et al., 2020) (Sulistiyorini, 2020) (Handayani, 2020) (Susanto & Azizah, 2025). When implemented within LMS-supported environments, PjBL may further enhance learning through structured workflows, digital collaboration tools, and flexible access to learning resources.

However, most existing research has focused primarily on cognitive outcomes rather than dispositional aspects of critical thinking. Critical thinking disposition—including truth-seeking, open-mindedness, analyticity, systematicity, self-confidence, inquisitiveness, and maturity of judgment—reflects deeper learning characteristics that influence how students apply critical thinking consistently across contexts (Facione et al., 1997) (Facione, 2000b) (Connie, 2006). Empirical evidence examining how LMS-supported pedagogical strategies influence these dispositional dimensions remains limited.

From a technological pedagogical perspective, LMS environments provide structured digital learning spaces but do not automatically guarantee meaningful epistemic engagement or reflective learning processes (Widarto et al., 2020). While Project-Based Learning is theoretically aligned with critical thinking development, its effectiveness in fostering critical thinking disposition within LMS-supported learning environments requires further empirical investigation (Apriyanti et al., 2014) (Ardhyantama et al., 2020).

Therefore, this study aims to examine the effect of Learning Management System-supported Project-Based Learning on students' critical thinking disposition within a flexible learning environment implemented as part of institutional educational technology practices.

METHODS

This study employed a quasi-experimental design using a one-group pretest–posttest model (Cash & Stanković, 2016). The independent variable was the implementation of PjBL within an LMS-supported learning environment, while the dependent variable was students' CTD. The participants consisted of 93 undergraduate students enrolled in three core courses—Pulse Techniques, Signal Processing Techniques, and Electronics 3—offered by the Electronic Engineering Education Study Program, Faculty of Engineering, Universitas Negeri Jakarta, during the 2024/2025 even semester. In accordance with institutional policy, learning activities were conducted using a flexible learning approach that allowed online and blended implementation supported by the university LMS and synchronous communication tools.

PjBL was implemented through structured project assignments, collaborative group work, online consultations, and project presentations facilitated through LMS-supported

platforms. To ensure consistency of implementation, lecturers used observation sheets to monitor the execution of PjBL stages across courses.

CTD score was measured using a validated questionnaire developed by the researcher (Djarmiko et al., 2020). The instrument consists of 50 Likert-scale items representing seven dispositional dimensions. Data analysis included descriptive statistics, paired sample t-test, and the N-Gain index to determine both statistical significance and practical effectiveness (Hake, 1999). Data analysis included descriptive statistics, paired sample t-test, and the N-Gain index to determine both statistical significance and practical effectiveness (Hake, 1999).

RESULTS

The results of descriptive and inferential statistical analysis are presented in Table 1, while the distribution of individual score changes is shown in Table 2.

Table 1. Descriptive Statistics of Overall CTD Scores

Dimension	Pre-test		Post-test		t-value	Sig.(p)	N-Gain
	Mean	SD	Mean	SD			
Truth-seeking	18,52	1,74	18,72	1,68	1,04	0,15	0,04
Open-mindedness	14,84	1,76	14,73	1,82	-0,16	0,27	-0,02
Analyticity	33,84	3,85	35,04	3,70	4,40	0,00	0,12
Systematicity	17,06	1,87	17,61	1,77	3,71	0,00	0,19
Self-confidence	21,45	2,48	21,95	2,33	2,64	0,00	0,08
Inquisitiveness,	19,04	2,48	19,43	2,11	2,00	0,02	0,08
Maturity of judgment	34,17	3,37	34,83	3,89	2,50	0,01	0,11
7-CTD dimensions	158,92	13,19	162,41	12,84	4,57	0,00	0,09

Table 2. Distribution of Changes in Students' CTD Scores (Pre-test and Post-test)

CTD Scores Comparison	Number of Students	Percentage (%)
<i>Post-test > Pre-test</i>	51	54,84
<i>Post-test = Pre-test</i>	13	13,98
<i>Post-test < Pre-test</i>	29	31,18
Total	93	100

Note: CTD = Critical Thinking Disposition

Descriptive Statistics of Critical Thinking Disposition (CTD)

The results presented in Table 1 indicate that the mean CTD score increased from 158.92 (SD = 13.19) in the pre-test to 162.41 (SD = 12.84) in the post-test. The paired sample t-test shows that this increase is statistically significant ($t = 4.57$; $p < 0.05$), suggesting that the implementation of Learning Management System (LMS)-supported PjBL had a positive effect on students' critical thinking disposition.

Despite the statistically significant improvement, the N-Gain value of 0.09 indicates low practical-effectiveness. This finding suggests that while LMS-supported PjBL contributes to measurable changes in CTD scores, the magnitude of improvement remains limited. Such results highlight the distinction between statistical significance and educational effectiveness, where improvements may be statistically detectable but pedagogically modest.

Effects Across the Seven CTD Dimensions

A closer examination of individual CTD dimensions in Table 1 reveals that analyticity and systematicity demonstrated the most substantial improvements, with relatively higher t-values and N-Gain scores compared to other dimensions. These dimensions are closely associated with structured reasoning processes, logical analysis, and systematic problem-solving, which align with the procedural nature of project-based learning environments (Thomas & Ph, 2000)(Grant, 2002). The structured stages of PjBL—planning, implementation, and evaluation—likely facilitated students' engagement in organized analytical thinking.

Moderate improvements were also observed in self-confidence, inquisitiveness, and maturity of judgment. These dimensions reflect students' willingness to engage in inquiry and decision-making processes, which may be supported by collaborative activities and iterative project development facilitated through LMS platforms. However, the relatively low N-Gain values indicate that the depth of dispositional change remains limited.

In contrast, truth-seeking and open-mindedness did not show significant improvement. The open-mindedness dimension even exhibited a slight decrease in post-test scores. This finding suggests that epistemic dimensions of critical thinking disposition may require more intensive reflective dialogue, argumentative discussion, and exposure to diverse perspectives than those typically emphasized in project-oriented activities alone. Previous studies have suggested that dispositional aspects of critical thinking tend to be more stable and may require sustained pedagogical interventions beyond structured project tasks (Facione, 2000b)(Baysura, 2016).

Distribution of Score Changes

The distribution of individual score changes presented in Table 2 provides additional insight into the variability of learning outcomes. While 54.84% of students demonstrated increased CTD scores, 13.98% showed no change, and 31.18% experienced a decrease. This variation indicates that the impact of LMS-supported PjBL was not uniform across participants. Differences in self-regulated learning skills, engagement levels, digital learning readiness, and participation in collaborative processes may have influenced individual outcomes.

Interpretation within Institutional Educational Technology Practices

From a technological pedagogical perspective, the LMS-supported environment enabled structured learning management, asynchronous interaction, and flexible access to learning resources. However, LMS integration alone does not automatically guarantee deeper dispositional development. The findings suggest that additional instructional strategies—such as reflective discussions, peer argumentation, and metacognitive scaffolding—may be necessary to enhance epistemic dimensions of critical thinking disposition within LMS-supported learning environments.

Overall, the results presented in Table 1 and Table 2 indicate that LMS-supported Project-Based Learning is effective in strengthening procedural aspects of critical thinking disposition but has limited impact on deeper dispositional dimensions without complementary pedagogical interventions.

Discussion

The findings indicate that LMS-supported Project-Based Learning significantly improves students' critical thinking disposition from a statistical perspective, although the practical impact remains limited. These findings are consistent with previous studies (Thomas & Ph, 2000)(Grant, 2002) which suggest that PjBL is effective in improving structured thinking skills, particularly in procedural dimensions(Thomas & Ph, 2000)(Vollrath, 2016). The results reinforce the theoretical perspective that technology integration alone is insufficient to foster deep learning dispositions without appropriate pedagogical design. Practically, the findings suggest that LMS-supported learning should incorporate reflective dialogue, argumentation, and metacognitive scaffolding(Purbawati et al., 2020)(Ramadhani, 2020). This is particularly important because the results showed limited improvement in epistemic dimensions such as truth-seeking and open-mindedness. Without structured opportunities for reflection and argumentation, students tend to focus primarily on procedural task completion rather than deeper critical engagement. Therefore, integrating reflective discussions, peer argumentation, and guided questioning within LMS environments is essential to enhance students' critical thinking disposition more comprehensively.

CONCLUSION

Based on the results presented in Table 1 and Table 2, this study concludes that the implementation of Learning Management System (LMS)-supported Project-Based Learning significantly improves students' critical thinking disposition from a statistical perspective. The paired sample t-test results indicate a significant increase in overall critical thinking disposition scores after the implementation of LMS-supported PjBL, demonstrating that technology-mediated project-based learning environments can positively influence students' learning dispositions.

However, the relatively low N-Gain values indicate that the practical effectiveness of LMS-supported PjBL remains limited. The findings show that the most substantial improvements occurred in procedural dimensions of critical thinking disposition, particularly analyticity and systematicity, suggesting that structured project activities effectively support logical reasoning and systematic problem-solving. In contrast, epistemic dimensions such as truth-seeking and open-mindedness showed minimal improvement, indicating that deeper dispositional aspects require more intensive reflective and dialogic learning experiences.

The distribution of individual score changes shown in Table 2 further indicates variability in learning outcomes among students. While a majority of participants experienced improvement, a significant proportion showed limited or negative change, suggesting that individual differences in engagement, self-regulated learning, and participation within LMS-supported environments may influence the effectiveness of instructional strategies.

From an educational technology perspective, the findings highlight that LMS integration alone does not automatically guarantee meaningful dispositional development. Instead, effective instructional design remains critical in shaping how technology-mediated learning environments support higher-order thinking. Therefore, LMS-supported Project-Based Learning should be complemented with pedagogical strategies that promote reflective dialogue, argumentation, metacognitive activities, and epistemic engagement to enhance students' critical thinking disposition more comprehensively.

Overall, this study contributes to the field of educational technology by providing

empirical evidence that LMS-supported project-based learning can support procedural aspects of critical thinking disposition, while also emphasizing the importance of instructional design in maximizing the pedagogical impact of technology integration.

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